SEGments

Journal of the Scientific Expedition Group Inc.

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Scientific Expedition Group Inc.

Cover Photo: A greater stick-nest rat. Photo: Australian Wildlife Conservancy

Rear Cover Photo: Yellow-footed Rock Wallaby, near Arkaroola Waterhole. Photo: Alun Thomas

The Scientific Expedition Group is a not-for-profit organisation which began in 1984. SEG undertakes several expeditions each year to record scientific information on wildlife and the environment in many parts of South Australia.

A major expedition to conduct a biodiversity survey occurs each year over two weeks. Scientific experts lead volunteers in surveying mammals, reptiles, invertebrates, vegetation, birds and physical geography. The data collected on each survey are archived with the relevant State scientific institutions to ensure they are available to anyone interested in our State's environment.

In addition to the major expedition, a number of trips for the Vulkathunha-Gammon Ranges Scientific Project are organised annually. A long term study of rainfall on the ranges and of water flow in arid-zone creeks is undertaken. All data are supplied to the Department for Environment and Water and to the Bureau of Meteorology and are available for analysis.

SEG conducts four-day biodiversity surveys at eight different sites each autumn and spring in the Heritage Area of scrub on "Minnawarra" farm near Myponga. Data collected are entered into the Biological Data Base of SA. SEG also conducts mallee fowl monitoring in the Murraylands.

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SEGments is the authorised journal publication of the Scientific Expedition Group Inc., 111 Franklin St, Adelaide, SA 5000. It is published four times a year to promote articles about biodiversity, scientific exploration and ecological research.

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EDITORIAL

This Editorial is not an editorial in the normal form but I am taking the opportunity as President (one of my other hats) to discuss a few things going on in SEG.

First, as I have mentioned in earlier Editorials the committee is now at full strength and the committee feels dynamic. I have a good feeling for the future for SEG.

Second, as a bit of a disappointment the committee has decided that our truck which has done many years valuable service is to be phased out (the polite term for getting rid of). There are a number of reasons for this. The truck is essentially a commercial vehicle and even though the truck is only used perhaps once a year the tyres have to be replaced every ten years. They are already older than that. Next, it hasn't been on a field trip for a number of years and requires a full and comprehensive service. Also the truck driver has to have at least a light truck license and apparently we do not have a member with such a drivers licence.

We obtained the truck originally because we were able to purchase a canopy from the Department of Environment and Water (or one of its predecessors) which was surplus to their needs. Stuart Pillman spent a lot of time and energy adapting the truck and canopy and we ended up with a unit which could store and carry essentially all of our trapping, camping and cooking equipment. It was of course supplemented by our food trailer to carry the actual food. A difficulty was that the combined unit was very high and it was difficult to find a shed for storing it. Hence the truck lived outside in all weathers. The equipment inside the canopy was well protected but the truck has suffered from weathering.

An estimate of the cost of getting the truck back into full working order was about $10,000 and if we went down that path we would still have the problem that we had no one to drive it.

The committee has now decided to purchase another cage trailer with a canvas cover for about $3600.

We do not need the new trailer for the upcoming Arkaroola Expedition 2024 as we do not need to take camping gear or much of the cooking gear. Along with the necessary survey gear we can get everything into the existing cage trailer. We will take the food trailer for what food we are taking and personal gear.

Finally I will also take this opportunity to discuss two positions within SEG which need filling. Neither of these positions need be members of the committee.

A first is Membership Officer. This is a straightforward position preferably for someone with computer skills to keep a record of membership status and able to supply listings, such as email listings for various purposes, to organisers of events and the like. At present we do not have an easily accessible listing for all purposes.

Another position is for an Assistant Editor of SEGments. Again this person does not need to be an existing member of the committee. The Assistant Editor is particularly required to assist in finding suitable articles and reviewing and checking the prepared SEGments.

If anyone is interested in either of these positions please contact me in the first instance.

Alun Thomas
Editor
alunulna@gmail.com

CONSERVATION GENETICS AND ADAPTIVE MANAGEMENT OF THE GREATER STICK-NEST RAT

Isabelle Onley

Introduction

The greater stick-nest rat (*Leporillus conditor*) is one of the many endemic Australian small mammals that have been driven to the brink of extinction since European arrival, with introduced predators, land use changes, and competition with introduced grazers fragmenting the species' populations and habitat. It is a rodent about the size of a guinea pig, with soft brown fur and rounded ears. The greater stick-nest rat is herbivorous and demonstrates a preference for succulents such as saltbush. As the name suggests, the species is characterised by its architectural abilities. Using sticks, grass, and a special ingredient – extremely sticky urine – greater stick-nest rats build communal nests that can reach sizes of 2 m wide and 1.5 m high, and are so strong they can last for thousands of years (Figure 1). Up to twenty rats may live in a single nest. The species has also been observed nesting beneath rocky outcrops and sheltering in the warrens of other species, such as the burrowing bettong.

Despite its nifty sheltering strategies, by the 1930s, the greater stick-nest rat was extinct on mainland Australia. Its former range, once encompassing the majority of the southern half of the continent, had been reduced to a single population on the Franklin Islands, off the coast of South Australia. Given the rapid nature of this range contraction, very little is known about the historical diversity of the species, and its habitat requirements or climate tolerance thresholds beyond the Franklin Islands. The greater stick-nest rat has been the subject of a number of translocations since the 1980s, both to other islands and to mainland refuges. Although some reintroductions failed, often due to an inability to exclude predators, many were successful. The greater stick-nest rat now has several meta-populations that can act not only as insurance populations, but as sources for future translocations. I was fortunate enough to study this charismatic species for my PhD research, with a focus on conservation genetics and adaptive management strategies under climate change, and will share some of my findings in this article.

Understanding size and shape variation within a species is important to threatened species conservation for a number of reasons. It can assist in resolving taxonomic issues, identifying population structure and conservation units, and understanding environmental adaptations. Rodents in particular can demonstrate significant morphological variation across geographic ranges – species in arid habitats, for example, may have larger ear bones to detect low frequency sounds, and longer nasal passages to aid in respiratory water retention. When developing translocation strategies, it is therefore important to consider whether the source population is well-adapted to the recipient environment. Understanding morphological variation across a species' range can assist with this, but that information can be challenging to

Figure 1. Isabelle Onley with a greater stick-nest rat nest at Arid Recovery Reserve, South Australia. Photo: G. Neave

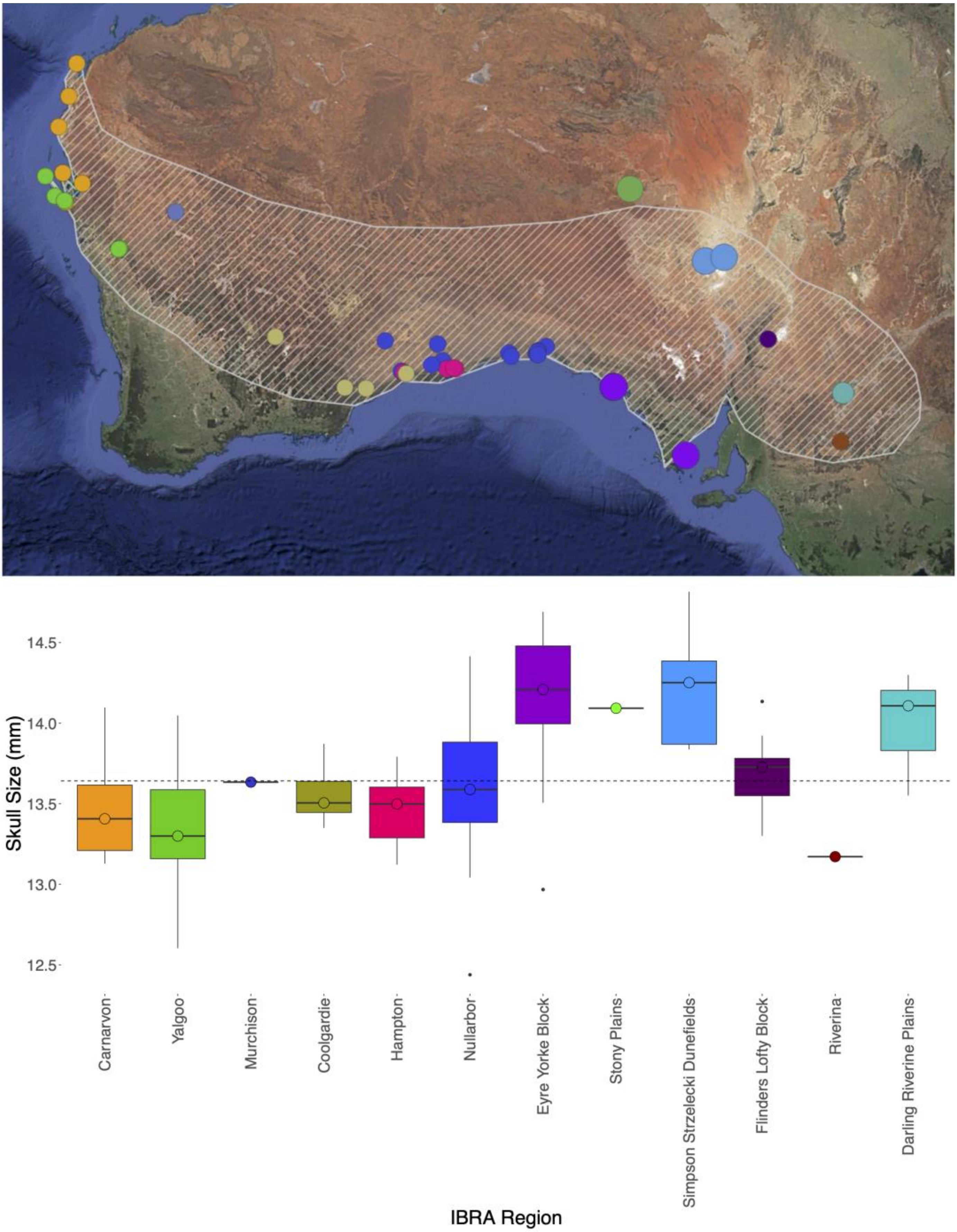

Figure 2. Skull size of greater stick-nest rats by IBRA region, corresponding to a map of collection locations across the historic range of the species. Dotted horizontal line indicates overall mean skull size.

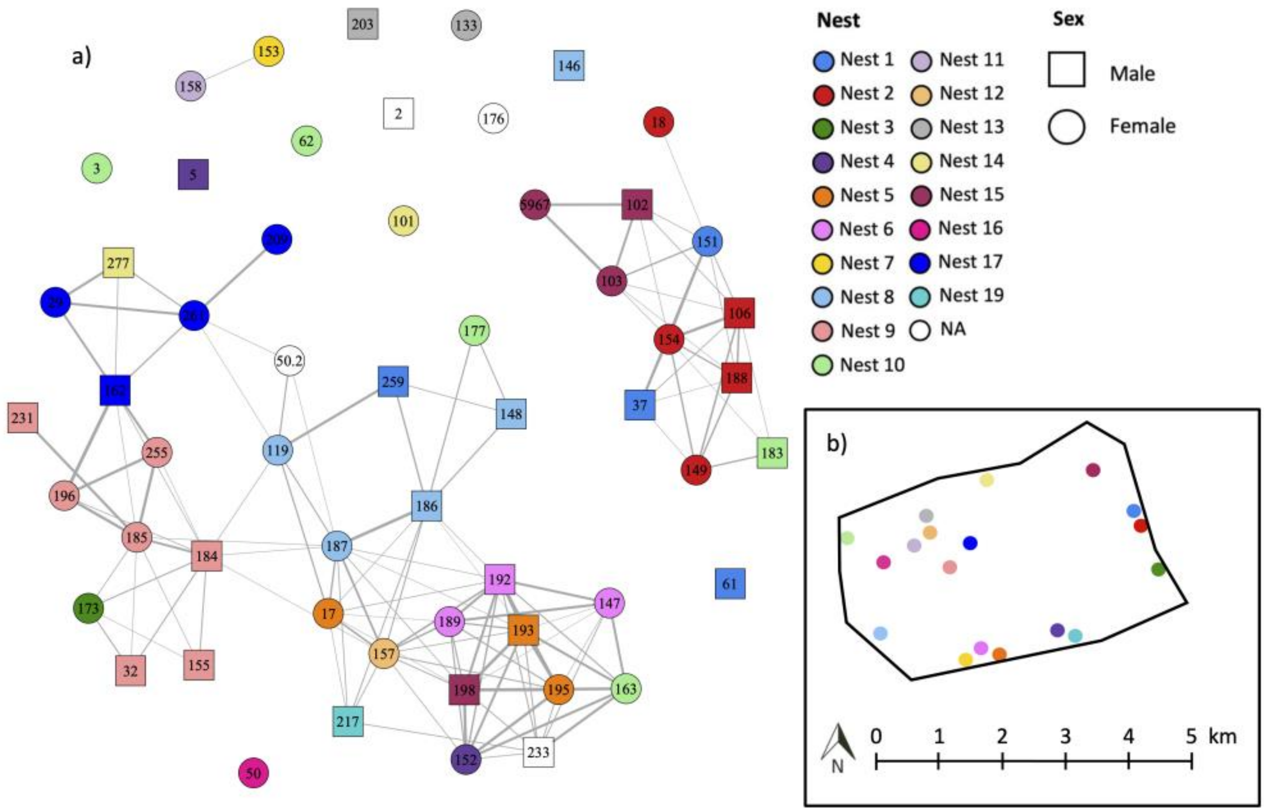

Figure 3. a) Relatedness network of male and female greater stick-nest rats at Arid Recovery Reserve, coloured by nesting site. Thickness of links indicates degree of relatedness. b) Map of nest sites within the Reserve.

attain when a species has undergone a rapid range contraction, as in the case of the greater stick-nest rat and many other small Australian mammals.

Thankfully, natural history collections provide an excellent resource that can help us to understand the historical diversity of species. We measured a total of 199 partial and whole greater stick-nest rat skulls from 34 locations across the species' former range, sourced from the South Australian Museum, the Western Australian Museum, and Museums Victoria. Using 15 linear measurements of the cranium and mandible, taken using digital calipers, we analysed the size and shape of the specimens according to their Interim Biogeographic Regionalisation for Australia (IBRA) classification, a means of capturing environmental variation.

It was found that while the species did not demonstrate significant variation in skull shape between locations, there were notable size differences across the historical range. This is a common observation in Australian rodents – many species demonstrate low variation in skull shape, with size explaining most of their variation. This may be an evolutionary adaptation that is the key to rodents' success in a variety of habitats. Analyses of greater stick-nest rat specimens showed that individuals from the Franklin Islands (the last surviving population), as well as a translocated population on Reevesby Island sourced from the Franklin Islands, and historical individuals from the Simpson Strzelecki Dune fields were significantly larger than all other sampled locations. (Figure 2)

The large size of the Franklin Islands individuals may be a response to predation pressure from black tiger snakes and barn owls, as no other major herbivores occupy the island. Such pressures may also apply to the individuals from the central arid zone (all of which were collected in close proximity to the Lake Eyre Basin but not during or immediately following a flood year). Perhaps these larger individuals from the two locations once belonged to a continuous population that became separated by rising sea levels ~8,000 years ago. Other explanations for the large size of the arid individuals could be "ecological release", a phenomenon that occurs when closely related species of similar size compete intensely, or an adaptive increase in body size and therefore surface area to volume ratio, which makes thermoregulatory costs lower for animals in highly variable environments.

This study found that the source individuals for contemporary translocations from the Franklin Islands are likely larger than their extinct mainland counterparts in the majority of locations, with the exception of central Australia. It is difficult to determine whether this variation has an impact on the fitness of translocated individuals, however the lack of shape variation within the species is encouraging, as it indicates that the greater stick-nest rat has a universally well-adapted cranial form and may be capable of simply scaling its body size when necessary to fit an ecological niche. This research also demonstrates the value in conducting morphological studies on range-contracted species prior to commencing reintroduction programs.

Dispersal patterns

Sociality and dispersal behaviour in mammals has many benefits for both individuals and populations. In mammalian systems, it is common for males to disperse from their birth territory, while females remain close to their place of birth and often pass on warrens or nests to their daughters. Some of the positives of this type of social structure include the sharing of knowledge on food and shelter resources, cooperative care of young, and avoiding inbreeding. Sex-biased dispersal can also have genetic consequences, such as increased relatedness between females within territories. For translocated populations, it is important to consider dispersal patterns, as understanding the social structure of a species can aid in selecting founder individuals and release strategies for maximum population viability and conservation outcomes. For example, in a species with male-biased dispersal, selecting individuals from a single geographic location will likely result in highly related females in the new population. However, if the dispersal behaviour of a species is well understood, conservationists can maximise the genetic diversity of the translocated population by sampling across a landscape and selecting as many unrelated individuals as possible.

Although the greater stick-nest rat has been the focus of a number of translocation programs, the dispersal behaviour of the species has not been studied extensively in the past. The nests they build are known to be communal and believed to be shared among family groups, however little is known about how they are passed down from generation to generation. In order to improve understanding of greater stick -nest rat dispersal behaviours for improved conservation success in the future, we studied a population of translocated greater stick-nest rats at Arid Recovery Reserve, South Australia, using trapping and genetic data from the first four years of their reintroduction.

Between 1999 and 2002 (inclusive), tail tips were collected from 56 individuals across 18 nest sites within Arid Recovery Reserve during routine trapping and monitoring. Individuals were a mixture of age classes, and trapping effort was equal across all known nests in the reserve. Traps were set in close proximity to the nests, and so individuals caught were presumed to inhabit that nest. DNA was extracted from tissue and submitted to a commercial sequencing company, Diversity Arrays Pty Ltd, for genotyping. We then designed a sex assignment pipeline to analyse the resulting DNA sequences and formally identify the sex of each individual. Following this, we conducted kinship analysis between all possible pairings in the dataset. We examined the degree of relatedness between male-male, female-female, and female-male pairings within and between nests within the reserve. If sex biased dispersal was occurring, individuals of the dispersing sex were expected to demonstrate lower relatedness than the sex that stays within the family territory. We also analysed the spatial genetic structure of males and females, and finally examined trapping data to identify whether rates of recapture at the same nests were higher for males or females.

We discovered that female-female kinship was significantly higher within the same nest than between nest sites, while male-male kinship was universally low and not significantly different whether within the same nest or between different nests (Figure 3). In the spatial genetic analysis, females were most strongly related in shared locations (<0.5 km), while males showed much lower relatedness in shared locations, and this relatedness remained consistent to distances of c. 1.5 km. We also found that females demonstrated a much higher rate of recapture at the same nest than males. Collectively, this indicates that greater stick-nest rats demonstrate a matriarchal social system in which females remain in the natal nest and inherit territories from their mothers and/or female relatives, while males disperse into the landscape when they reach maturity.

This discovery has a number of implications for the conservation management of the greater stick-nest rat. Post-release dispersal is an important, but often overlooked, component of translocation success or failure, so understanding dispersal patterns of this species is likely to be important for the ongoing success of future translocation programs. Selection of wild-caught individuals for translocation from a source population is often opportunistic or transect-based and heavily impacted by factors such as trapping success and accessible terrain, and guidelines around sampling regimes for translocations are limited. However, sex biased dispersal can result in fine-scale spatial genetic structuring, a factor that should be considered when harvesting individuals to establish a new colony. Selection of multiple females from the same location in a species demonstrating male dispersal will likely result in a higher degree of relatedness than desired and could increase the risk of inbreeding depression in the new population, but on the other hand it must also be acknowledged that several studies on mammals demonstrating kin clustering have noted an increase in translocation success when entire family groups were harvested. This has been attributed to the benefits associated with resource sharing, as well as reduced aggression and stress and increased site fidelity during reintroduction. Consequently, when translocating a species wherein females stay in their home territory, managers should consider the importance of increasing long-term genetic diversity by selecting unrelated founding individuals against the potential survival benefits of maintaining close familial associations.

Based on our results, we proposed guidelines for spatially explicit harvesting of greater stick-nest rats for translocation in the future. We found that relatedness is significantly decreased beyond a 0.5 km radius of nest sites for females and 1.5 km for males; an appropriate harvesting strategy would therefore involve selecting small cohorts of males and females from multiple adjacent nest sites which are then separated from the next group by a minimum distance of 1.5 km. This would allow for founding females to retain family groups, while simultaneously maximising genetic diversity and reducing the risk of inbreeding. Post-release monitoring of future translocations would inform on the consistency of this spatial genetic structure when dispersal distances are not limited by fencing.

Furthermore, in greater stick-nest rats, permanent nest structures appear to be inherited maternally, and are maintained and used by subsequent generations of related females, a strategy that has been shown to improve offspring survival in other species. As the construction of such large and complex shelter sites is energetically expensive, resource inheritance by female kin has an added survival advantage, namely that subsequent generations of females in established nests are not required to expend large amounts of energy on founding a new nest and can therefore prioritise foraging for food and caring for young. Since nest sites are central to the breeding behaviour of the greater stick-nest rat, the presence of adequate nesting sites should be a consideration for future conservation of the species. Suitable habitat for future translocations of the greater stick-nest rat should contain a variety of nesting substrates and materials within close proximity, providing ample shelter for both dispersing males and females remaining in their natal territory. Shelter substrates should ideally not be more than 300-500 m apart, as this was the maximum distance travelled by females in the trapping dataset that visited nearby nests.

Our research demonstrated the first empirical evidence of sex-biased dispersal behaviour in the greater stick-nest rat. Based on these results, we were able to make two key recommendations for future translocations of greater stick-nest rats using wild stock. Firstly, an adaptive design for trapping founders, and secondly, as greater stick-nest rat matrilineal groups rely on the generational construction and maintenance of nest sites that require a high degree of energy investment, future conservation programs should consider releasing founder individuals in family groups into patches of optimal nesting habitat, thereby encouraging shelter establishment, maintaining group structure, and limiting panic dispersal.

Conclusion

This article summarises the results of two chapters from my PhD thesis on the conservation of the greater stick-nest rat, and demonstrates the value of a multi-disciplinary approach to the management of threatened species, particularly when planning translocation programs. It is hoped that the findings of this research can be extrapolated to other Australian endemics with similar histories of range contraction and fragmentation, and will contribute to the ongoing protection of threatened species in the face of climate change. During my degree, I became incredibly fond of these charismatic and industrious little builders, and I hope to see many positive conservation outcomes for them in the future.

Research presented in this article can be found at:

Onley, I.R., Moseby, K.E., Austin, J.J. and Sherratt, E., 2022. Morphological variation in skull shape and size across extinct and extant populations of the greater stick-nest rat (Leporillus conditor): implications for translocation. Australian Mammalogy, 44(3), pp.352-363.

Onley, I.R., Austin, J.J., Mitchell, K.J. and Moseby, K.E., 2022. Understanding dispersal patterns can inform future translocation strategies: A case study of the threatened greater stick-nest rat (Leporillus conditor). Austral Ecology, 47 (2), pp.203-215.

Additional chapters of my PhD thesis can be found at:

Onley, I.R., Moseby, K.E. and Austin, J.J., 2021. Genomic approaches for conservation management in Australia under climate change. Life, 11(7), p.653.

Onley, I.R., Austin, J.J. and Mitchell, K.J., 2021. Sex assignment in a non-model organism in the absence of field records using Diversity Arrays Technology (DArT) data. Conservation Genetics Resources, 13, pp.255-260.

Onley, I.R., White, L.C., Moseby, K.E., Copley, P. and Cowen, S., 2023. Disproportionate admixture improves reintroduction outcomes despite the use of low-diversity source populations: population viability analysis for a translocation of the greater stick-nest rat. Animal Conservation, 26(2), pp.216-227.

The entire thesis is available at:

Onley, I.R., 2022. Conservation genomics and adaptive management of translocated greater stick-nest rats (Leporillus conditor) under climate change (Doctoral dissertation). https://hdl.handle.net/2440/135975

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CONSERVATION COUNCIL AWARDS
Alun Thomas

At the recent Conservation Council Awards SEG Chairman Bob Sharrad was presented with a Lifetime Achievement Award.

Bob's citation read:

"Dr Bob Sharrad is a respected field biologist and naturalist who has dedicated his life to the study of the environment and advocating for its importance.

Though Bob has spent much of his life teaching trainee teachers and rangers, a significant proportion of his time has been spent studying wildlife in the field, often in remote sites in Australia and overseas.

His research work – most notably studying South Australian reptiles – is formidable and has helped improve our understanding of the value of these fascinating creatures.

Bob has been a core contributor to Nature Foundation SA, serving as President, Vice President, Honourary Secretary and Councillor. Through this association he has contributed to a variety of conservation research projects in collaboration with government agencies and administers Bushbank, postgraduate scholarships, a land purchase fund, and the Para Woodland project.

As an environment science expert, Bob has served on countless boards and advisory committees, helping form the projects and policies that protect and nurture our state's natural environment.

In 2021, Bob was made a Member of the Order of Australia for his service to the environment through leadership of community conservation organisations, particularly the Nature Foundation of South Australia, and through science education and ecological field studies."

The Award was presented by Kirsty Bevan, Chief Executive of Conservation SA and also a SEG committee member.

At the same awards ceremony, my mother Patricia Thomas, nee Mawson was posthumously also presented with a Lifetime Achievement Award. The award was received by my brother Gareth Thomas and me.

My Mother's citation read:

"Patricia Thomas was born in Melbourne in 1915, the eldest daughter of Sir Douglas and Lady Paquita Mawson.

She graduated from the University of Adelaide with a Bachelor of Science and completed a Masters degree in Zoology in 1938, studying Australian nematode parasites.

From 1950 to 1980, she raised three sons while continuing to work within the University's Department of Zoology, publishing groundbreaking research and travelling the world to engage with the brightest minds in the field.

Patricia acted as editor for many of the series of scientific reports resulting from her father's expeditions to Antarctica, covering botanical and zoological explorations between 1929 and 1931

Pat Thomas' most significant scientific legacy lies in the more than 100 papers published throughout her career.

It is widely acknowledged that Pat's research represents the most significant single contribution to our knowledge of the nematode parasites of marsupials of the 20th century.

Pat was awarded the Verco Medal of the Royal Society of South Australia in 1974 and became the first woman to be made a Fellow of the Australian Society for Parasitology. In 1994, Pat was awarded an Order of Australia for her contributions to science in Australia.

Aside from her pioneering research, Pat will also be remembered for her generous hospitality, her culinary skills, her sense of humour and particularly for her generosity in sharing scientific work."

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Bob Sharrad being presented his award by Kirsty Bevan

Kirsty Bevan presented a Lifetime Achievement Award posthumously to Patricia Thomas which was received by her sons Alun and Gareth Thomas.

VULKATHUNHA-GAMMON RANGES DATA RECOVERY TRIP 19 – 23/4/2024

Garry Trethewey

Garry & Michelle Trethewey did this excursion to do photopoint vegetation photos, document bell-fruit trees, to observe any other opportune sightings of interest, and make a rough assessment of effects of fire on equipment and biota. Again we thank Operation Flinders for allowing us to stay at Owieandana.

This trip followed a major fire four months ago. Lots of things on the ground changed, and a lot of our plans and responses.

We thought our water cache would probably have survived the fire of December 2023, but in case it was burnt, the task of our first day was to carry water up the creek. That would give us a bit of spare time, so we also took gear for assessing bell-fruit trees – paperwork, range pole, pH test kit, etc. In the event, we found our water cache had burned, evaporated or melted.

There had been some rain a month or so before. A small pool out of the fire area had lots of tadpoles, some frogs, algae, water beetles. And The Seeps was up – about 60cm diameter of visible water.

About 300m before the Wild Ass Creek, we came to the burnt area, and suddenly all visual landmarks changed. 'The Pink Gum Tree' that marked a creek crossing wasn't there. There was a strange hill we'd never seen before. Previously we'd glimpsed a treed hillside through the scrub – now an unimpeded view of a big bare hillside.

Wild Ass Waterhole was half full, with a rim of ash-mud. It had no visible life in it, except lots of tiny flies (*Brachydeutera sp?*) flitting across the top. Using a range pole as a makeshift Secchi disk, I estimated 30cm visibility. All pools were the same, clogged and lifeless, except for one very slow runnel, ~400ml / hr, that had algae growing in the bottom.

Further along, the eastmost of Bob Henzel's exclosures was burned out but the wiring is nearly intact. Given the 'reset' after the fire, I'm considering adding exclosure photos to my list of photopoints.

Many of our photopoints have star droppers &/or DEH (now DEW) baseplates marking them, but many used trees as landmarks. Many of these have disappeared, so I'm rewriting the guidebook to use more distant hill slopes. As veg grows back, it will have to be updated.

Alex's tech party was due to arrive next day, to deal with Plateau Pluviometer, which stopped sending in the fire. We found the pluviometer itself intact, but it's telemetry looked ruined. All external cables, the antenna, and the weatherproof box were burnt &/or melted. The key had also melted, but once we got inside the box, (where all the $$ are kept) we found all its contents intact with an LED still flashing. Next day Alex's tech party found that the data logger below the pluviometer was intact, so the missing 4 months of data will soon appear on the web. https://water.data.sa.gov.au/Data/DataSet/Interval/Latest

I've been thinking a bit about mechanisms for rock weathering and erosion. Prominent here is fire-flaking.

Flaking in a fire, another way that rock breaks down.

Vertebrates.

There seem to be a few more euros around, but I think that's because of the vastly improved visibility. Two red roos on the totally burnt plateau – how do they get there? The other party saw a group of 12 goats near North Tusk, so that's the first we've seen around Arcoona Creek – North Tusk – Plateau since the drought. (cf hundreds between Copley and Mt Searle). Donkey footprints & poos, probably a single animal. *Ctenophorus modestus* - half a dozen including juveniles at higher elevations.

Slender Bell-fruit Trees.

To briefly recap the history and intent of this project: two years ago we found a large number of slender bell-fruit trees had suddenly sprung up where none had been seen before. Because their life history is largely unknown, this presented an opportunity to observe them from year one, through several generations of mallee-like stem death & re-sprout, until final death.

The fire stopped that. Of 75 trees we had previously observed, only one was not in the burnt area. For all the others, the main trunk was killed, often with leaves still intact, and well over half are putting out basal regrowth. This will present other opportunities, e.g. as herbivores continue to

A grove of slender bell-fruit trees before the fire of December 2023

After the fire

recover after the 2018-19 drought, we can observe any browsing and bark-scraping.

Interestingly, although killed, most of these trees are still standing, and are visually prominent with their yellow stems, where almost all the other vegetation has disappeared.

I noticed that several authorities, re-quoting the same source, say bell-fruit trees grow in soil with a pH of 8.5 – 9. I think this is misleading. It doesn't exclude growing in a much lower pH, and it talks about habitats that are unlikely to have such a high pH.

I'd brought a gardener's soil pH kit. For most of the trees there was a layer of ash on the surface, pH 8.5, but for 11 trees I dug 8cm deep, 50cm from a tree, through ash, rock and gravel to get a bit of clean sand, finding the pH was 6 to 7. Rainwater from home was pH 7, and from a pool near our camp was pH 8.

We removed from the sites burnt 20 litre water drums and replaced them with 8 x 15 litre drums, mainly full.

Scientific Expedition Group

40th Birthday Celebrations and

Annual General Meeting

Sunday 20th September 2024

To be held at The Volunteer Centre at Long Gully, Belair National Park commencing at 12 Noon.

The Speaker will be Peter Copley who will speak on

"Scientific Expeditions of a Threatened Species Ecologist"

For catering purposes please advise SEG Secretary Sarah Telfer on sarahtelfer490@gmail.com of your intention to attend.

MINNAWARRA BIODIVERSITY SURVEY REPORTS

Richard Willing

Apologies for the lateness of these reports, but illness has disrupted the family and dictated other priorities. Many thanks to all those who gathered around on both occasions enabling the surveys to proceed, with uninterrupted data collection. With such experienced staff we were sometimes able to have three teams on trap rounds, pleasing both humans and small mammals.

Minnawarra Survey Spring 2023

This survey ran from 7th - 11th October 2023. The days were mild and sunny, but the nights were cold. The forecast for an overnight temperature of 5C on 7th October caused the closure of all traps that afternoon, eliminating any captures on the next morning round. The five days were fine with some cloud and max temperatures increasing from 13 to 23C.

Rats and Bats is a fair description of the small mammals of this survey. Bush Rats (R. fuscipes) were dominant - 67 individuals were trapped, 26 were recaptures from previous surveys, visiting 103 times; Swamp Rats (R. lutreolus) 46 individuals, 13 recaps, 92 visits; Antechinus in short supply, 22 animals, 12 recap, 53 visits. Totals of small mammals: 135, including 51 recaptures from previous surveys were caught 84 times in spite of a truncated trapping program. Busiest: Site 7 next to swamp in distant South paddock, and Site 5 next to Cannabis Creek, 84 mammals microchipped. The Harp Trap set up for a couple of nights captured several bats. 4 Little Forest Bats (Vespadalis vulthurnus) is a species new to Minnawarra; also, a Lesser Long Eared Bat (Nyctophilus geoffreyi) which is common in the area. It was warm enough for a few skinks to appear, mostly Garden (L. guichenotii) but also Hemiergis decresiensis and Bassiana triliniaris and a Red Bellied Black snake. (Pseudechis porphyriacus). Thanks to Helen Owens, someone who can think like a bat when setting up the Harp trap. And thanks again to the very special volunteers who made it all happen.

Minnawarra Survey Autumn 2024

This survey ran from April 13th - 17th 2024, once again staffed by an enthusiastic group of SEG supporters. The weather was ideal, controlled by a stationary high pressure system, with calm winds, a couple of light showers, and max temp varying from 1 to 18C.

We had a very busy few days trapping 211 individuals 365 times. 2 were recaptures from previous surveys. The commonest species were bush rats (R. fuscipes) 95 rats, 10

Clarentina (in the purple jacket with the tan strip on her jumper) is an international student from Indonesia who has helped at the last two surveys. Her extended family were in Adelaide from the USA and Indonesia to attend her MBA graduation. They joined a session at Minnawarra to understand what Clarentina has tried to explain to them! Also in the photo is Ramsey, Steven-Khoa and Peter Reuter. Photo: Anthea Habel recaptures from previous survey, 152 visits; Yellow Footed Antechinus (A. flavipes) 73, including 8 recaptures, 136 visits; Swamp rats (R. lutreolus) 25 rats, 4 recaptures, 40 visits. The busiest site was Site 2, (on the edge of a swamp, south of the road near the west end of the property) where 38 individuals were captured 64 times. This represents 171 new native mammals captured and microchipped in this survey. It may be a record for us, certainly one of our busiest surveys. In spite of the sun, it was too cool for most skinks, 1 of the 12 captures being Garden Skinks (L. guichenotii).

Once again, many thanks to the skilled people who came together to get a great result. In spite of a very dry autumn the Minnawarra biome looks to be in good health.

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Peter Reuter, Jill Tugwell and Connor at site 9. Jill is inserting a microchip into a Bush Rat. Photo : Anthea Habel

Alun Thomas and Phil Davill cleaning the Elliot traps after the Spring survey. There are 120 traps to clean after each survey. Made simpler by a high pressure water sprayer. Photo: Anthea Habel

A new member Steven-Khoa Nguyen assisting on his first Minnawarra survey. Photo: Anthea Habel

Recording trapping data at Site 2. Isobel Barrett checking a microchipped animal and Alun Thomas recording the data on record sheets. Photo: Anthea Habel.

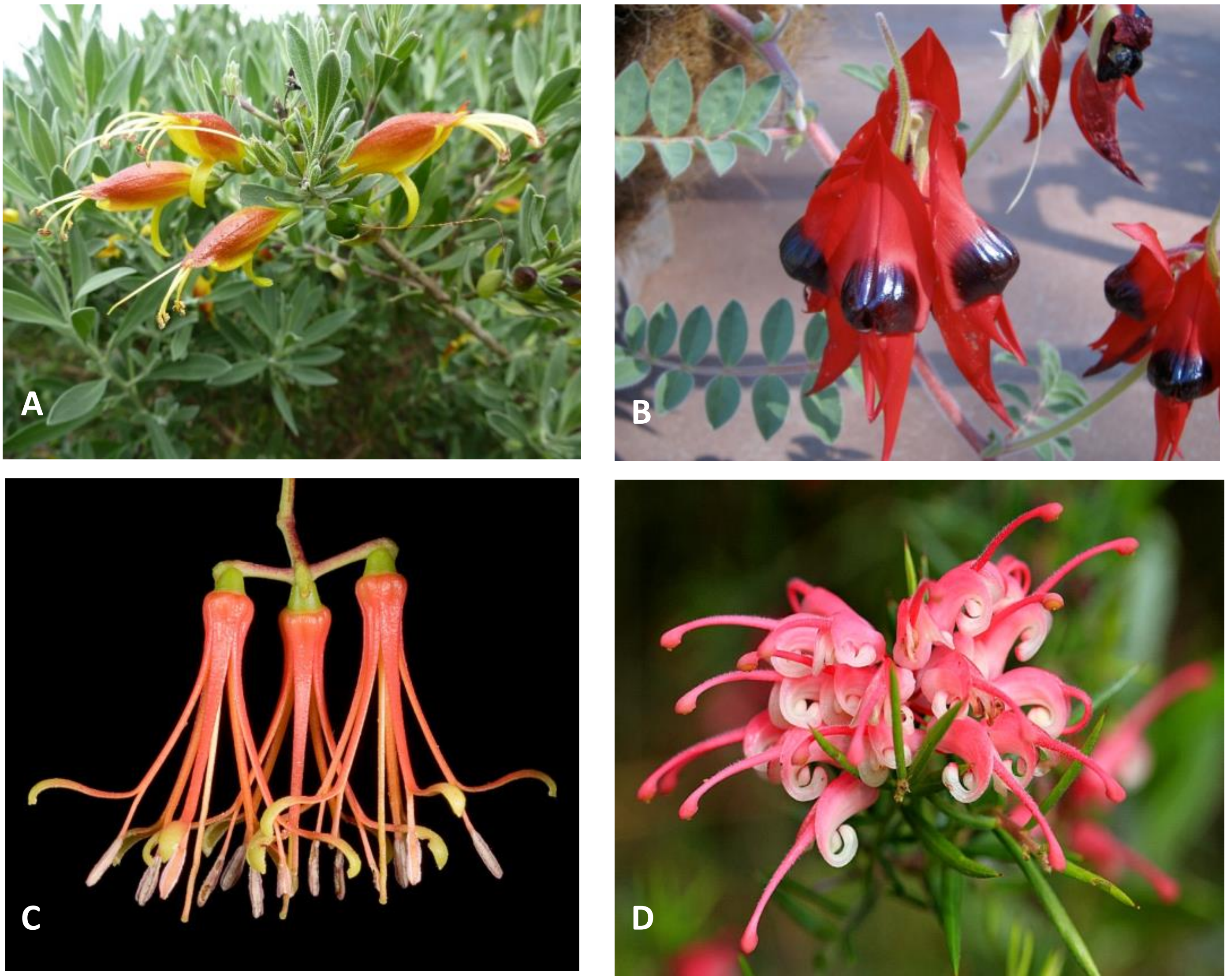
FLOWERS AND THEIR VISITORS: A LOVE-HATE RELATIONSHIP

Katja Hogendoorn

A few weeks after rain, arid areas can turn in stunning palettes of flowers. The colours and shapes can be truly mesmerising, and it is often difficult to grasp that the enormous diversity in floral designs is largely the result of selection for characters that can easily be perceived and remembered by pollinators.

Different plant species depend on different pollinators to maximise their chances of outbreeding. Detailed observation of flower shape, as well as colour and texture can help to understand the preferred pollinator species. For example, bird pollinated flowers are often red, sometimes yellow or whitish, and can have fleshy petals to protect themselves from sharp bird beaks. Think for instance, of the flowers of the tar bush (*Eremophila glabra)*, Sturt desert pea (*Swainsona formosa*), lavender grevillea (*Grevillea lavandulacea*) or wire leaf mistletoe (*Amyema preissii*). These deep flowers are designed to be pollinated by honey eaters. The birds use their long, brush-like tongue to collect nectar, and the flower morphology ensures that the pollen is deposited at the base of their beak, or, in the case of Swainsona on their abdomen. If the plant is lucky, the birds transports the pollen to the next plant and deposits it on the stigma. By contrast, many Eucalyptus species are adapted to pollination by lorikeets or cockatoos, that lick the floral cup with their round, scaly tongues.

Although Australia as a continent has a very high diversity of bird pollinated plants, most flowers are pollinated by flying insects. The simple reason for this lies in numbers: 80 % of all terrestrial animal species are insects, and it is estimated that they outnumber birds by a factor 10^8. Among insect dependent plants, there is, again, specificity. A range of plants have co-opted pollination services from specific groups of flies, wasps, moths, butterflies or beetles, and have developed adaptations that facilitate pollination by these insects. But very few plants species completely depend on a single pollinator species, and a disproportionate number rely on bees for pollination. This is because, unlike most other flower visitors,



Four bird pollinated species: A *Eremophila glabra* (photo: Geoff Derrin); B *Swainsona formosa* (photo: Heather of Adelaide); C *Amyema preissii* (photo: Kevin Thiele); D *Grevillea lavandulacea* (photo: Ratabago from Adelaide) bees depend on floral resources throughout their lifecycle: both adults and larvae eat pollen as their sole protein source and use nectar for their carbs. Bees are experts at picking up pollen and most species have specialised hairs for pollen collection. As a result, many flowers have colours and smells that are attractive to bees, and may produce pollen or nectar that is nutritious to them.

But co-evolution is not the whole part of the story. Most plants that depend on animal pollination are faced with a conundrum. Pollen is rich in protein and fat, and while it is in the interest of the plant to have its pollen delivered, the plant doesn't benefit when it is consumed. So, the floral resources need to be accessible to legitimate pollinators, and at the same time protected from non-pollinating freeloaders. To achieve this, many plants have evolved measures to prevent non-pollinators taking their pollen or nectar. In other words, the diversity of flower morphology is the product of both coevolution, and an arms race to prevent unproductive loss of loss of floral resources. In the following, we will see three examples of this, all from arid South Australia.

Senna

Senna is a ubiquitous plant in arid South Australia. It is hardy, and toxic to cattle. It is also among the buzz pollinated plants, which, like *Solanum* species, such as tomato and the spiny *Solanums* of outback Australia, hide their pollen inside the anthers. The anthers of buzz pollinated plants have one or more pores at the top, which allow buzz pollinating bees to release the pollen by vibrating the flower. Only a selection of bee species can buzz pollinate. Therefore, reliance on buzz pollination, which evolved numerous times independently among flowering plants, drastically limits the number of species than can take the pollen. But the flower of *Senna* has yet another trick up its sleeve to ensure that not all pollen end up in bee stomachs. The flower has two types of anthers – seven shorter anthers that are directed towards the centre of the flower and three, longer, reproductive anthers. The reproductive anthers are directed towards a curved petal that is entirely smooth on the inside. The bee takes hold of the shorter anthers and vibrates to release the pollen, which is caught in the branched hairs on the underside of its body. However, as the shorter anthers are buzzed, the longer anthers also vibrate and release pollen. This pollen ricochets upwards along the curved petal and lands on top of the bee, where the bee cannot brush it off. The bee then moves to a next flower, and if this is the mirror image of the flower it visited first, the curved stigma will scoop the pollen off the bee. That way, *Senna* satisfies the pollinator, while preserving some of the pollen to for its own goal: pollination.

Eremophila

Apart from the fleshy red bird pollinated species mentioned above, there is a range of blue/white/ purple *Eremophila* species with papery flowers, which are mainly pollinated by bees. The bee-pollinated *Eremophila* species use two strategies to limit access to nectar by non-pollinating insects. First, the flower has a constriction in the base, that allows only very tiny insects through, and allows bees with narrow faces to push their way in and to access the nectar using their extremely long labial palps. Narrow faces have evolved independently in three groups of bees, and these are all *Eremophila* specialists. Second, most small insects are

The flowers of *Senna artemisoides,* showing the configuration of the anthers. Note the pollen on the thorax of the buzzing bee (photos: James Dorey).

The flowers of many *Eremophila* species, including *E. scoparia,* have a constriction at the base and are hairy on the inside (photo: Melburnian).

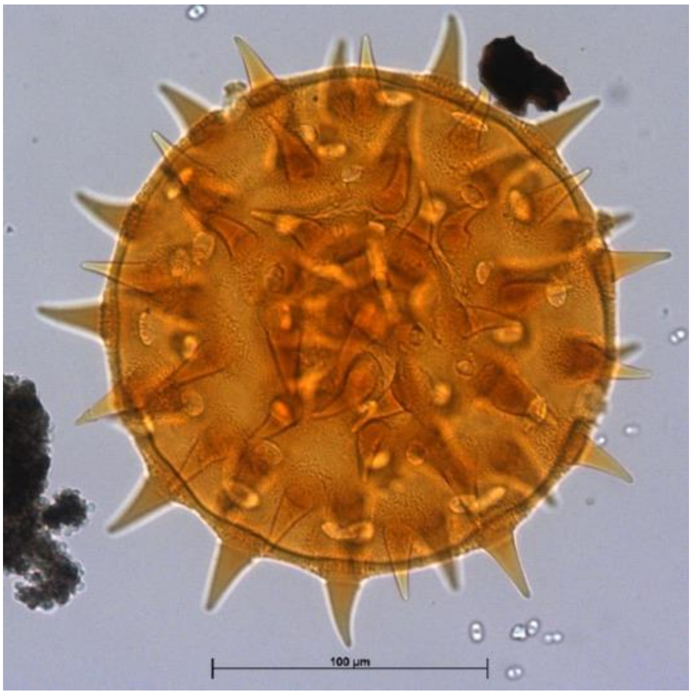
The narrow face of Native Bee *Euhesma aulaca*, first discovered on Bon Bon station in 2010, allows it to push into the constriction at the base of the flower and harvest the nectar using its long labial palps Photo: Katja Hogendoorn and Remko Leijs).

bothered by a forest of sticky hairs on the inside of the flower, and struggle to make their way in. Hairiness is common among Australian flowers, and its function first came to my attention when I noticed ants collecting nectar on *Eremophila longifolia* after the petals had fallen off. These were large ants, so they might have been able to push their way through the constriction, but apparently they could not make it into the flower. Ants are everywhere and often not the best transporters of pollen, so hairy flowers may be a common strategy to preserve nectar sources for better pollinators.

Gossypium and *Alyogyne*

Not all plants protect themselves against freeloaders by limiting access to pollen or nectar. Some plant species have exposed pollen that is difficult to collect or digest. For example, pollen from Malvaceae, such as Sturt's Desert Rose (*Gossypium sturtianum*) and *Alyogyne* species, is readily accessible for all flying insects. But the pollen kernels are approximately twice the diameter compared to those of most bee plants, and are very spiky. Research has shown that packing large spiky pollen kernels into collection hairs presents a problem for generalist bee species. As a consequence, one would rarely see honey bees collecting pollen on these

Sturt's Desert Rose (photo: Mark Marathon)



An example of a large spiky pollen kernel in the Malvaceae (Australian Pollen and Spore atlas).

flowers. In addition, there is some evidence that the spikes may be irritant. Spiky pollen is often brushed off by honey bees, and may be difficult to digest, in particular for bee larvae. Despite this, bees in some groups, such as *Lithurgus* and *Phenacolletes mimus*, have found a way of dealing with these problems, and specialise on Malvaceae.

There are many more examples of such morphological adaptations to protect floral resources. In addition to that, toxic substances in pollen are also likely to be part of the lines of defence used by the plants. Although we know that secondary plant metabolites are expressed in pollen and can be toxic to bees, we are only just discovering the co-evolution and warfare that is going on in this context. Understanding the presence of chemical defences involves extensive chemical analysis and feeding experiments with bees or bee larvae in laboratory settings, things that cannot easily be done in the field.

Despite this, there is a lot that can be discovered simply by watching. Not only are the colours and shapes of flowers informative, the pollination strategy developed by plants can often be gleaned by noticing what animals visit which plant species, whether they collect nectar only or also pollen, and specifically, what potential thieves are kept out and how. Much of this can be learnt in the field using diligent observation and a hand lens.

In summary, the colours and shapes of flowers and pollen have not just evolved to attract pollinators, but also to deter the mere visitors. For me, the realisation that flower traits are the result of a combination of co-evolution and an arms race has been an eye-opener and a source of fascination. When I'm out in the field, it gives me real joy to watch, speculate and try to understand the special relationships between plants and their pollinators, as well as the barriers that nature has thrown up to disallow the many pollen and nectar thieves.

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CORRECTION

In a recent article – 'Revegetating the entrance to Balcanoona headquarters in the Vulkathunha-Gammon Ranges National Park', published in SEGments, 40 (1) June 2024 on Page16 – we wrote that Uncle Gill Coulthard was the first indigenous Park ranger in SA. Information gained since then indicates that an accurate account would say, including the information within part of the original paragraph, headed 'Steeped in history':

"A bygone era is recorded in a self-guided trail with signage that includes historical photographs and stories from Uncle Gill Coulthard, who was employed in significant roles assisting the senior ranger at Balcanoona, the Park headquarters, in the early days after Balcanoona station was added to the then Gammon Ranges National Park. Forty years on senior ranger Sian Johnson, shares her rich Adnyamathnha cultural and environmental knowledge with visitors."

Marg Easson & Richard Smith

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ARKAROOLA RECONNOITRE

Alun Thomas

Trent Porter, Piers Brissenden Jill Tugwell and I went up to Arkaroola Nature Reserve to check sites and to confirm accommodation etc.

SEG has twice before surveyed on Arkaroola and the aim of the reconnaissance was to confirm that sites could be located and choose which of the sites would be surveyed on the upcoming trip. A number of the sites are to the south and to the east of Arkaroola headquarters and the rest are on the Ridgetop Track to the north of the Arkaroola Headquarters.

We went up to Arkaroola on Wednesday 3 July and spent the next day checking sites to the south and to the east of Arkaroola headquarters. We also got to site 1 on the Ridgetop Track. Unfortunately significant rain occurred over Thursday evening and Friday morning and even the experienced Arkaroola drivers could not go out on the Ridgetop Track. We were intending to go home on the Saturday anyway so we decided to leave on Friday.

We discussed accommodation and meals with the Arkaroola management and they have offered accommodation in the Greenwood Lodge and several other lodges as necessary.

This means that breakfasts and dinners will be provided at the Arkaroola Native Pine Restaurant. All alcoholic drinks served in the Pick and Shovel Bar or with meals will be the responsibility and at the cost of the individual expeditioners.

The Arkaroola management are also providing a separate area for the science room.

alunulna@gmail.com

Looking from Site 1 on the Ridgetop Track back towards the Arkaroola Headquarters.

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